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the human stem species that have aborted some parts, as for example, some of the digits of the foot, or the hindermost molars. Such species will be nearer completion and less capable of further advance; their mental growth as well as their bodily development will be to some extent arrested by the abortion of the parts. If, on the other hand, a portion of the descendants of existing humanity acquire the power of using their feet to perform one set of delicate offices in obedience to the orders of the brain while the hands perform another set, and of using right or left limbs equally well, a vast increase of mental power will be the concomitant of such an acquisition. In many other directions there are possibilities, the eye may gain a power of adjustment that will convert it into microscope and telescope, the ear become ably to close itself at will as is the eye, the touch become far finer than it is now in those most sensitive.

Certain it is, at any rate, that a wide range of physical capabilities is essential to high mental development. The Houyhnhym reads well in Gulliver's Travels, but an animal whose limbs are degraded to a line of levers can never advance mentally. Mind is an animal characteristic, and a classification of animals which leaves it out is a one-sided classification.

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THE NATURALIST BRAZILIAN EXPEDITION.

BY HERBERT H. SMITH.

SECOND PAPER.—THE LOWER JACUHY AND SÃO JERONYMO.

(*Continued from page 716.*)

I WILL now describe the main geological features of the São Jeronymo district, which I studied carefully during several weeks, traversing all parts of it on foot or on horseback. My observations here extended over a space about forty miles long and twenty broad, comprehending the country south of the Jacuhy to the Serra do Herval, between the Arroio da Porteira on the west and the Arroio dos Ratos and Arroio da Divisa on the east.

I have stated that the hills generally trend east and west. Traveling southward from the Jacuhy, about forty miles, five main ridges are passed, each of which is successively higher than the preceding. The first, at its highest point, is about 600 feet

above the river, but it is generally much lower. Succeeding this is an irregular swampy valley, two or three miles wide; then another ridge, somewhat higher, descending on the southern side to the Arroio dos Ratos, which here flows nearly east. Beyond the Arroio is another ridge, still higher, crossing which we reach several small streams, branches of the Arroio da Divisa, which cut through this ridge from south to north. The fourth ridge, which immediately follows, is rugged and almost mountainous in its character, and higher than any of the preceding. It is followed by a wide, deep valley, on the southern side of which is the fifth ridge, properly the eastern end of the Serra do Herval, which at this point is probably 2400 feet above the Jacuhy.

All of these ridges are composed of massive red granite, either coarse or fine. It is intersected here and there by quartz veins, varying in thickness from a few inches to many hundred feet. Commonly these veins appear as little ridges on the surface; larger ones form long hills, as may be seen just south of the Arroio dos Ratos, on the road to Dous Passaros. The quartz varies from translucent to white or granular.

Above the granite in some places are layers of gneiss and mica schist. These are well seen in the beds of streams between the third and fourth ridges which I have described, about five miles south of the Arroio dos Ratos. Here the layers are very much twisted and distorted, but the stratification is quite evident. Most of the layers are rich in mica, breaking with a schistose fracture, but some are massive, resembling the gray gneiss of Rio de Janeiro. It is difficult to determine the strike, but this appears to be nearly E. W., corresponding to the trend of the granite ridges; some of the folds are perpendicular or reversed; I did not see them in contact with the granite, but they are apparently unconformable. Gneiss is also seen south of the fourth ridge, in the bed of a stream; here it is massive, and I saw no signs of mica schist.

Overlying granite and gneiss, but seen only in the hollows between the ridges, are layers of stratified and unaltered rocks, forming the third great system seen here. In the São Jeronymo district these beds appear in three portions or basins; first, between the Rio Jacuhy and the first ridge; second, between the first and second ridges; third, between the fourth and fifth ridges, just north of the Serra do Herval. The strike varies from E. W.

to S. E., N. W., the dip is generally a slight one to the N. or N. E., but sometimes to the S. or S. W. Thus, in general, the strike of these beds also approximates to the trend of the granite ridges.

On the southern flank of the fourth ridge the stratified rocks are seen lying directly over the granite; they consist here of sandstones, with layers of sandy shale, and two beds of coal, the whole dipping S. W. at an angle of about 15° . The side of the granite ridge, between the stratified rock, is inclined to the south at an angle of nearly 20° . The approximate section, in ascending order, is as follows:

A. Granite.

B. 1. Coarse sandstone, 30 meters. This rock varies much in appearance as it has been more or less weathered. Where it lies flat on the hillsides or in the beds of streams, it is reddish or purplish in color, and very hard, breaking with an angular fracture. In cliffs, where it has been long exposed to the weather, it is white, soft and friable, and worn into curious forms resembling statuary. The stratification is irregular, and there are many instances of false bedding. I suppose that the rock was formed on a sea-shore, either in shallow water, exposed to winds and currents, or as blown sand in dunes. Towards the top there are some layers of sandy shale, not well exposed.

2. A layer of sandstone, rich in iron, about two meters. Where this rock has been long exposed to the weather the silicious matter has been partly washed away, leaving the iron oxydes in concentric layers. These form balls varying from twelve to twenty-five centimeters in diameter. By selecting the richest specimens ore may be obtained yielding forty to sixty per cent of metallic iron.

3. Clay conglomerate, two meters. The pebbles are silicious, small and irregularly strewn in layers.

4. Silicious conglomerate, three meters, increasing in fineness towards the top and passing into

5. Coarse reddish sandstone, eight meters.

6. Red micaceous shale, three meters.

7. Whitish shale, five meters. Probably this was originally a dark shale, with much carbonaceous matter, the white color being due to weathering.

8. Coarse sandstone, fifteen meters.

9. Sandy shale, one meter.
10. Impure shaly coal, one meter.
11. Sandy shales, ten meters.
12. Coal resembling No. 10, two-thirds meter.
13. Sandy shales, ten meters.

These are apparently followed by other layers of sandstone and sandy shales to a thickness of forty or fifty meters. It should be stated that the thicknesses given above are merely approximate and, in part, suppositional, the sections being much obscured.

The coal at this place, called Dous Passaros, was mined many years ago by an Englishman named Johnson, this being in fact the first coal mine opened in the province. The coal was carried to Porto Alegre, over fifty miles, in ox-carts or on the backs of mules; owing to this difficulty of transport, and to the poor quality of the product, the mine never paid expenses, and it has long been abandoned. I found the shaft-house in ruins, covered with weeds and vines, the shaft itself being nearly full of water. The coal appeared near by in the bed of a stream.

Economically the most valuable basin of the three which I have mentioned, is the middle one, or that lying between the first and second granite ridges, about thirteen kilometers south of São Jeronymo. The stratified rocks here occupy a long oval space, extending about fifteen kilometers from east to west, the greatest width being five kilometers. The rocks strike nearly E. S. E., the dip being a very slight one to the N. N. E. The section, in the main, agrees with that which I have just described,¹ the position of the sandstone and conglomerate beds, and the layer of iron-ore, being the same. Instead of two layers of coal there is only one, but this is much thicker and the coal is of better quality than that of the Dous Passaros mine.

In 1870 the "Imperial Brazilian Collieries Company" was formed in London, with the object of extracting the coal of this basin; 100,000 pounds sterling of capital was subscribed, and the Brazilian government readily granted permission to explore the São Jeronymo district and establish mines in any part of it. Engineers having reported favorably, work was commenced at once, over fifty miners being brought over from England. Unfortu-

¹ By an unfortunate accident my notes of the section at the mine, and of three other artificial sections, were lost.

nately the entire capital was exhausted in preliminary works, including the railroad to the river shore at São Jeronymo, and the company failed; the mine and railroad with all privileges, were sold at a low price, the purchasers being the house of Holtzweissig & Co., of Porto Alegre. The coal has since been worked by them, but on a small scale, the enterprise being in fact beyond their resources. The original horizontal mine of the English company was abandoned and the present perpendicular shaft was sunk; this is known as the Arroio dos Ratos mine. The quality of the coal varies somewhat, certain portions of it being interstratified with shaly rock, and containing lumps of iron pyrites. By experiments made on government steamers it appears that the average São Jeronymo coal gives, ton for ton, about thirty per cent less steam than good Cardiff coal; there is a proportionally larger quantity of ash, requiring more labor for its removal, but the engineers in this case reported little difficulty with clinkers or stones; other engineers, however, say that the furnaces become clogged, and they suggest a modification of the grates to meet the difficulty.¹ In igniting power the São Jeronymo coal is probably superior to the Cardiff, the fires being lighted and steam got up quicker with this than with the English coal. On the whole the São Jeronymo coal appears to be well enough fitted for stationary engines, freight locomotives and river steamers; for ocean steamers it may serve if mixed with better grades. It does not coke well, and its adaptability for gas making is doubtful. The coal is in good demand in the province, where English is very high, owing to the difficulty that coaling ships experience in passing the bar at Porto Alegre and Rio Grande. Comparing the prices paid at Porto Alegre and Rio Grande (April, 1882), I find that the São Jeronymo coal, where it can be used, is much cheaper. This will appear from a simple calculation:

This Sao Jeronymo coal costs at Porto Alegre.....	per ton, 15 milreis.
At Rio Grande.....	“ 18 “
Cardiff coal costs at Porto Alegre.....	“ 32 “
At Rio Grande	“ 28 “
Difference in favor of the Sao Jeronymo coal at Porto Alegre	“ 17 “
At Rio Grande	“ 10 “

The milreis, by present exchange, is worth about forty-four cents.

¹ Latterly the quality of the coal has been much better than when the experiments were made.

Allowing a difference of thirty per cent for the inferiority of the Brazilian coal and the greater labor required in using it, it would still have the advantage over the English coal in cheapness. If it were mined on a larger scale this advantage would be much greater, and if the difficulty of the bar could be overcome it might even pay to carry it to Rio de Janeiro and the Rio de la Plata. The Brazilian Minister of Marine, a year or two ago, offered to contract with Holtzweissig & Co., for the coaling of the government war steamers, the coal to be delivered in Rio de Janeiro; but the house being unable to comply with the conditions did not accept the contract.¹

I am unable to compare the Rio Grande coal with that of Santa Catharina, but from such information as I can obtain, it appears that the mines of the latter province suffer the disadvantage of being too far from navigable waters, and especially from good ports. The São Jeronymo coal, on the contrary, requires only a short railroad transit, and it can be loaded directly at the river banks near São Jeronymo; large steamers, as I have said, ascend to this point.

The iron-ore bed, of which I have spoken, appears on the surface about two kilometers south of the coal mine, in the bed of a stream; the ore here is of reasonably good quality, but I do not think it would repay the cost of working, especially as the coal does not appear to be fitted for the reduction of metals. Beneath the surface the unweathered layer is comparatively poor in iron. It would appear, in fact, that a boring made beneath the coal in the Arroio dos Ratos mine passes directly through this layer, which is here indistinguishable from the rock above and below it.

Between the Rio Jacuhy and the first granite ridge the coal-bearing rocks again appear, but those on the surface are higher in the series than the section of the Arroio dos Ratos mine, and three trial borings have failed to reach profitable coal. In the last boring at Xarqueadas, twelve kilometers east of São Jeronymo, traces of petroleum were obtained.

The coal rocks in this basin are much obscured by eruptions of a dark, fine-grained basaltic rock, which is occasionally columnar; it is well seen about two kilometers S. W. of São Jeron-

¹ In practical questions relating to coal, the field geologist labors under great disadvantages, his opinion being in fact far less valuable than that of a competent engineer. The data on which the above paragraphs are based have been carefully collected from many sources, and used with much caution.

ymo, and farther on in the bed of the Arroio da Porteirinha. By the decomposition of this and of porphyritic rocks farther up the river, immense quantities of agates, chalcedonies and cornelians have been formed; very fine specimens may be picked up in the streets of São Jeronymo, and they are found all along the river shore to the mouth of the Arroio dos Ratos. Similar and still finer agates are found to the north and west of this point, some of them being nearly a meter in diameter; some of the finest are exported to Germany, and the trade is already of considerable importance. The price paid for agates in Porto Alegre is ten milreis, or about \$4.40 per barrel.

The river shore at São Jeronymo and opposite Triumpho is formed of granite, this being the last that I have seen of the rock in this direction. The stratified beds farther north overlie the coal rocks. I shall have occasion to speak of them in another article.

In the bed of the Arroio da Porteirinha, and on the campos between it and the coal mine fragments of silicious wood are found; logs of this are so well preserved that they might readily be mistaken for half-rotten posts. Similar silicified wood occurs in large quantities in the districts to the north of the Jacuhy, but I have never found it in place. It is clearly much newer than the coal rocks, probably Quaternary or recent.

Passing in review the geological section which I have described, it will be seen that the basal granite forms a series of east-and-west ridges, successively increasing in height from the Jacuhy to the Serra do Herval. The Serra, so far as I have any knowledge of it, is formed throughout of granite, and on the opposite or southern side there are other granite ridges, successively lower, to the Rio Camaquã; the coal rocks, if I may trust to the information of herdsmen, reappear in valleys between these. The Serra do Herval must therefore be considered as the backbone of an area of upheaval which raised not only the granite but the overlying gneiss and coal rocks. The dip and strike are modified by intrusions of trap, but the general inclination is always away from the central ridge. Thus, in passing north or south from the Serra do Herval we find successively newer rocks on the surface, and this rule holds good for some distance beyond the Jacuhy.

Unfortunately the age of the coal beds is still somewhat problematical, owing to the absence of fossils; the only recognizable

organic remains which I saw were some fragments of *Lepidodendron* from the strata immediately overlying the coal bed at the Arroio dos Ratos mine. These were much compressed and broken, but the generic characters were still clearly recognizable, and they are sufficient to establish the Paleozoic age of the beds. Beyond this I can only give it as my decided opinion that the coal rocks are of the Carboniferous period, and probably coeval with the Santa Catharina coal formations.

The question arises whether the coal beds were laid down in one sheet, which was subsequently folded as the ridges were formed, and then denuded over their tops; or whether the ridges already existed when the coal beds were formed, the latter having been deposited in the valleys between them? It appears to me that the ridges were partly raised before the coal beds were formed; that the latter were first laid down in the hollows, but gradually the upper beds extended over the granite hills. Subsequently the ridges were raised still higher, and the sedimentary rocks were denuded away from the granite on their summits. The original continuity of the beds appears to be proven by the general conformity of the sections in the three basins which I have described; but the inclination of the coal rocks is everywhere much less than that of the sides of the granite ridges.

Another question is important in an economical sense; Are there other beds of coal below that which is now worked in the Arroio dos Ratos mine? I think not. It seems certain that the section in this basin is the same as that at Dous Passaros, where the coal rocks lie directly on the granite, and no trace is seen of another coal bed below the iron-ore layer. As it appears that this latter bed has been cut in excavations made below the coal, I believe that further borings would only show layers of sandstone followed, at no great depth, by the granite.

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ON THE SHELLS OF THE COLORADO DESERT AND THE REGION FARTHER EAST.¹

BY ROBERT E.. C. STEARNS.

PART I.—THE PHYSAS OF INDIO.

ABOUT four years ago I called attention to certain specimens of fossil shells contained in a lump of earth taken from the

¹ This paper was read before the California Academy of Sciences, June 5, 1883. It may be regarded as supplementary to my "Remarks on Fossil Shells from the Colorado desert," published in the *NATURALIST*, Vol. XIII, March, 1879.